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ABSTRACT

Attitude toward mathematics is often characterized as being either positive or negative, that is, essentially a one-dimensional phenomenon. This research was an investigation of construct validity for attitude toward mathematics. The Mathematics Attitude Scale developed by Aiken and Dreger (1961) was administered to 148 tenth graders. A principal components factor analysis of the scores revealed two factors: (1) enjoyment and (2) fear or anxiety that together accounted for 64 percent of the total variance. Thus, attitude toward mathematics appears to be a two-dimensional phenomenon that mathematics teachers and teacher educators might address with specific strategies. The 20-item scale and factor structure coefficients for each item are included. (Author/GDC)

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CONSTRUCT VALIDATION OF ATTITUDES TOWARD MATHEMATICS

Abstract

Attitude toward mathematics is often characterized as being either positive or negative, that is, essentially a one-dimensional phenomenon. This research was an investigation of construct validity for attitude toward mathematics. The instrument developed by Aiken and Dreger (1961) was administered to 148 tenth graders. A principal components factor analysis of the scores revealed two factors--one of enjoyment and the other of fear--that together accounted for 64 percent of the total variance. Thus, attitude toward mathematics appears to be a two-dimensional phenomenon that mathematics teachers and teacher educators might address with specific strategies.

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Introduction

Mathematics is one of those subjects in which students apparently have definite attitudes that develop at an early time in the school years; either they like mathematics or they do not. For example. Fedon (1958) reported that students as early as the third grade had formed a liking or a disliking for this school subject. Sister Josephina (1959) found that is a sample of 900 fifth, sixth, seventh, and eighth grade students, mathematics ranked among the top three subject areas as well as among the bottom three least preferred subject areas. This trend appears again in Roland and Inskeep's study (1963) in which, out of 10 content areas polled, students indicated their first liked and their fifth most disliked school course was mathematics. Thus, there are a number of studies that have shown students are rarely ambivalent in their attitudes toward mathematics.

While some researchers have shown that many students have either a friendly or a hostile feeling for mathematics, others have described a relationship between attitude toward mathematics and achievement in mathematics. Using Dutton's scale, Bassham and others (1962) found that among sixth grade students with negative attitudes four times more students underachieved than overachieved the appropriate grade level; and among sixth-graders with positive attitudes, three times more youngsters over-achieved than underachieved. Glennon and Callahan (1968) cite several other studies that have found a positive relationship between attitudes

toward arithmetic and achievement. Another facet of the research also discussed in conjunction with attitude is the concept of anxiety.

A variety of studies have suggested that a high anxiety is associated with low scores on arithmetic achievement tests (Feldhusen, 1965; McCandless and Castaneda, 1956; and Philips, 1962). Another study, Biggs (1965) revealed that anxiety restrained one's ability to learn mathematics and that "anxiety appears to be more easily aroused in learning mathematics than it is in other subjects."

Dreger and Aiken (1957), the authors of a well-known scale of mathematics attitude, determined that first-year college students have emotional reactions that can be called "number anxiety." Additionally, it appears from this work that persons with high number anxiety tend to make lower grades in mathematics. With respect to elementary school children, Glennon and Callahan (1968) observe, that a teacher can be confident that high anxiety does have a debilitating effect upon achievement in elementary school mathematics.

Thus, the literature seems to reflect at least two attitudinal themes that affect one's achievement in mathematics. These two characteristics are degrees of enjoyment of mathematics and anxiety level with respect to mathematics. These two notions seem previously to have been coalesced in the single issue called attitude toward mathematics.

People who like mathematics mention their fascination with numbers or relationships that exist among various aspects of the discipline, others like the subject for the analytical value of many problems, and still others ascribe their positive regard for the discipline to the thrill they feel after solving some problem that has for a while

titillated their mind. These are features of mathematics that apparently lead people to enjoy mathematics. There are, of course, other feelings about the subject.

Some people say they feel helpless in math class, others reveal that to them mathematics is a maze of rules and symbols that requires a kind of memory that they do not have in order to escape the jungle, and others fear the subject without their being able to articulate a cause. These comments surely add further credence to the implication in previously cited literature that at least another dimension composes attitude toward mathematics - namely, an anxiety component.

Most instruments implicitly assumes that attitude toward mathematics is a unidimensional phenomenon, albeit bidirectional; that is, one may be said merely to like or to dislike mathematics (Aiken, 1977). The issue here was that attitude toward mathematics as currently measured might be of a more complex composition than the unidimensional phenomenon so often accepted. In particular, the simplest alternative position was that the construct at hand might in reality manifest a multidimensional quality instead of the aforementioned unidimensional one.

Remarkably enough, if these facets of attitude are independent, then it seemed plausible they could exist apart in the same individual. The literature indicates that one's attitude toward mathematics might be constituted by contributions from more than one dimension, components from degree of enjoyment and from degree of anxiety.

The problem, then, can be stated quite clearly: Is one's attitude toward mathematics multidimensional? The conjecture is that two dimensions,

one of enjoyment and one of anxiety, do exist in the composition of attitude toward mathematics. Thus, the focus of this study is one of construct validation of attitude toward mathematics with respect to the Aiken and Dreger (1961) instrument.

Procedures

The twenty-item scale developed by Aiken and Dreger (1961) uses a Likert type scoring procedure, respondents choosing one of five alternatives from strongly agree to strongly disagree. The authors' scoring procedure point to ten items of a positive nature and ten items of a negative nature being summed to produce a single score.

When dealing with measurement of an abstract psychological attribute, such as attitude, the discussion of construct validity is crucial. Both content validity and what Aiken and Dreger refer to as discriminant validity have been reported (Aiken and Dreger, 1961). However, construct validation is the major focus of this study. One aspect of such validation is the explication of underlying dimensions representing the degree of inter-relatedness of items (Nunally, 1967). Factor analytic techniques have generally been used in the search for constructs defined by multiple measures.

With regard to the present study, if the attitude instrument measures but one dimension, it would be expected that the reduction of the matrix of intercorrelations of the items would yield one factor. However, under consideration is the conjecture of a multidimensional attitude domain.

While the scale does differentiate between items to be scored positively and items to be scored negatively, the summation of those two scores implies unidimensionality of the attitude construct. Use of a factor analytic technique would serve to reveal the nature of the underlying structure of attitude toward mathematics.

Scores for 148 tenth grade mathematics students on each of the 20 items were used to form a matrix of inter-item correlations. That matrix was then submitted to a principal components factor analytic procedure.

Analysis and Results

The principal components factoring procedure revealed the existence of two factors accounting for 64 percent of the total variance. These two factors were then taken into rotation using the Varimax criterion. Examination of the factor structure coefficients was undertaken in an attempt to define the arising dimensions (Table 1).

TABLE 1

FACTOR STRUCTURE COEFFICIENTS

Item	Factors 1	2
1. I am always under a terrible strain in math class.	-.268	.628
2. I do not like mathematics, and it scares me to have to take it.	-.408	.612
3. Mathematics is very interesting to me, and I enjoy math courses.	.836	-.305
4. Mathematics is fascinating and fun.	.824	-.209
5. Mathematics makes me feel secure, and at the same time it is stimulating.	.679	-.211
6. My mind goes blank, and I am unable to think clearly when working math.	-.141	.763
7. I feel a sense of insecurity when attempting mathematics.	-.154	.723
8. Mathematics makes me feel uncomfortable, restless, irritable, and impatient.	-.396	.654
9. The feeling that I have toward mathematics is a good feeling.	.804	-.159
10. Mathematics makes me feel as though I'm lost in a jungle of numbers and can't find my way out.	-.281	.679
11. Mathematics is something which I enjoy a great deal.	.852	-.314
12. When I hear the word math, I have a feeling of dislike.	-.519	.492
13. I approach math with a feeling of hesitation, resulting from a fear of not being able to do math.	-.317	.784
14. I really like mathematics.	.835	-.308
15. Mathematics is a course in school which I have always enjoyed studying.	.763	-.303

16.	It makes me nervous to even think about having to do a math problem.	-.238	.746
17.	I have never liked math, and it is my most dreaded subject.	-.522	.518
18.	I am happier in a math class than in any other class.	.612	-.250
19.	I feel at ease in mathematics, and I like it very much.	.704	-.369
20.	I feel a definite positive reaction to mathematics; it's enjoyable.	.798	-.261

It is observed that, with the exception of Items 12 and 17, identification of the two factors is fairly clear. Items correlating with the first factor connote enjoyment, interest, fascination, stimulation, and comfort with mathematics. Examination of the second factor reveals expressions of strain, fright, confusion, hesitation, and fear when approaching mathematics. Interestingly enough, the items loading on both factors (12 and 17) evoke expressions both of enjoyment and of anxiety within the context of the same question.

Discussion

This construct validity investigation of the composition of attitude toward mathematics as reflected in the scores of subjects on the Revised Aiken and Dreger scale of mathematics attitude revealed an underlying structure of two factors. Simply, the first factor has been called enjoyment of mathematics; the second one has been called anxiety towards mathematics. Thus, this construct has, not a unidimensional (liking or disliking) character, but rather at least a two dimensional character - enjoyment and anxiety.

This finding should be of interest to mathematics teachers and teacher educators, for it lends additional weight to exhortations that teachers pay more than cursory attention to the possible impact of the affective domain on student achievement in mathematics. The implication is that at least two distinct types of teacher moves are possible in this regard: moves that promote enjoyment, and moves that alleviate anxiety. Further investigation might reveal whether teaching strategies that key on one or the other or both of these moves yield the best results in terms of of student performance.

Another area one must consider in light of these findings is that of scoring procedures. The conventional technique yields a single numerical result by means of weighing and summing positive and negative scores on each question. A new procedure for scoring based upon two scales, one each derived from the two factors, would seem in order.

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